Fig. 8. Fusiform spicules, plain and warty, from ectodermic layer between base of tentacles and edge of hard tube.
Fig. 9. Warty fusiform spicules.
Fig. 10. The same, gradually becoming coalesced and forming a rough irregular network at one spot; in another becoming solidified.

N.B. All the figures on this Plate have been drawn by Mr. Ford from specimens preserved in spirits. It need not be said that they are accurate representations of the structures thus preserved; yet they would undoubtedly have been much more life-like had they been drawn by Mr. Ford from living specimens. Figure 3, however, is not only an accurate but also to my mind a life-like drawing.

XLVIII.—*On the comparative Carpical Structure of the* Ehretiaceæ *and* Cordiaceæ. By John Miers, F.R.S., F.L.S., &c.

Thus far the carpical structure of the *Ehretiaceæ* has been explained, especially under the typical form of *Ehretia*; and it will tend to a better comprehension of the subject if I offer a few observations upon *Cordia*, because a very distinguished botanist has proposed to amalgamate *Ehretiaceæ* with *Cordiaceæ*. M. Baillon, in an instructive analysis of the ovary of *Cordia* (Adans. iii. 1, pl. 1), points to the analogy existing in the early development of the ovaries of *Cordia* and *Heliotropium*, and, without sufficient consideration of the subject, he pronounces these two genera to be inseparable; and, as the latter has been referred by some to *Ehretiaceæ*, he would unite the *Cordieæ*, *Ehretieæ*, *Heliotropieæ*, and *Borragineæ* into one family (*Cordiaceæ*). He thus divides it into two groups:—

1. *Borragineæ* proper.
2. *Cordiaceæ*, subdivided into
   - A. *Cordieæ*, having an embryo with plicated cotyledons.
   - B. *Heliotropieæ*, with simple cotyledons, without albumen.
   - C. *Tournefortieæ*, with simple cotyledons, with albumen.

But he does not state in which of these he would place the *Ehretiaceæ*.

These were the inferences he drew from his examination of the ovary of *Cordia ferruginea*; and he figured in the drawing above quoted the different stages observed from the period of the earliest development. He depicts the formation of two rudimentary carpels, which, by the inflexion of their margins, form a low dome with a unilocular cavity, in the bottom of which, intermediate between the four cardinal points, he perceived the evolution of four ovules, fixed in the base upon as many placentary ridges, while between them four septiform enlargements emanated from the wall of the cell at those cardinal points, leaving as many shallow fossets in the base

of the cell, where the ovules became ensconced; the parietal emanations tapered upwards, gradually closing and joining together so as to form the style and stigma; and while the cells thus produced continue to grow downwards, the anatropous ovules remain attached to their original placentary supports, with their micropyles pointing upwards. At this stage, M. Baillon's description ceases, and he does not relate what occurs in the further development of *Cordia*, or what takes place in *Heliotropium* or *Ehretia*. The differences in these subsequent developments may, however, be summarized in the following manner.

In *Cordia* the four parietal emanations gradually approach each other, to form four equal partitions united in the axis, so that, at the period of flowering, the ovary is completely 4-celled, with a single subanatropous ovule in each cell, attached to the internal angle by a point below its apex or by its middle: the completion of this growth results in a drupaceous fruit, with a 4-celled osseous nut, each cell with a single seed suspended from below the summit, with a descending raphe terminating in the basal chalaza, the radicle of the exalbuminous seed being superior, and the cotyledons singularly plicated lengthwise. In the base and centre of the nut a large hollow is seen filled with placentary tissue, from which four sets of nourishing vessels issue, penetrating through a minute perforation near the summit of each cell, and terminating in the hilar attachment of the seeds. These are the very peculiar transformations that serve to distinguish the *Cordiaceæ* from all other developments of the same alliance.

In *Ehretia*, the ovary at an early stage is developed much after the manner of *Cordia*: the rudiments of four ovules emanate at the same points, and we see four similar intermediate parietal enlargements; but the basal placentary ridges combine to form a compressed elevated line, running from front to back across the axis, which continues to grow upwards, carrying the ovules with it, or, what amounts to the same thing, the principal growth of the whole takes place downwards; and in this manner the placentary columella is produced, which M. Baillon does not seem to have noticed. On the other hand, the parietal enlargements do not meet round the axis, as in *Cordia*, but are thrust aside after a while; the sinister and dexter emanations form semisepta, which, on approaching the columella, become suddenly reflected both ways, in parallel directions, to meet the corresponding parietal growths from the anterior and posterior walls: the consequence is that, at the period of the perfection of the flower, we see two bilocular carpels, each cell having a suspended ovule, while a vacant

space runs across the axis anteriorly and posteriorly, filled with a compressed plate, which is the columella that supplies the nourishing vessels for the growth of ovules and seeds. This growth is constant throughout the *Ehretiaceæ*. The subsequent developments of the fruit in the different genera become modified in the manner already described.

In the *Borraginaceæ* there exists in the earlier stages a normally bicarpal development very similar to that of *Cordia*; but during the subsequent growth there is a tendency to a separation of the whole into four carpels, more or less bigeminately combined in pairs; the style remains free in the centre, supported upon a common gynobase, upon which the four carpels are affixed, and from which their ovules and seeds derive their nourishing vessels. This constitutes a subfamily marked by many peculiar characters: it requires, however, a thorough reinvestigation.

In the *Heliotropiaceæ*, the ovary, normally as well as at maturity, is bicarpellary, and the carpels are seated upon a conical gynobase of half their height. The style is usually very short, thick, and suddenly enlarged into a pulvinate or discoid form; and this is terminated by two sessile stigmata, more or less abbreviated. The fruit is generally exsuccous, divisible into four single or into two bilocular nuts; when four nuts are produced, there is a short placentary process that rises from the gynobase, to which the nucules are attached, and which answers the purpose of the columella seen in the *Ehretiaceæ*, in affording nutrition to the seeds; they are not bigeminately connected, as in that family.

Hence it will be seen that the *Cordiaceæ* possess characters which amply distinguish them from the *Ehretiaceæ*, *Heliotropiaceæ*, and *Borraginaceæ*. Nearly all the species of the family have been huddled into the single genus *Cordia*, because no one has taken the trouble to ascertain their true characters, their examination having been singularly neglected. It is remarkable that, among the 175 species of *Cordia* enumerated by De Candolle in his 'Prodromus,' the number of cells existing in the fruit is mentioned in only four cases, and utter silence is maintained throughout the whole in regard to the number of cells in the ovary, even in the generic character; and the point of suspension of the ovules and attachment of the seeds is everywhere ignored. Prof. Fresenius, in working the monograph of the family for Martius's 'Flora Brasiliensis,' contents himself with a few words in stating the ordinal character: in regard to its 4-locular ovary, he merely says there is an anatropous ovule in each cell, appended from the summit (which is not exactly true); and in regard to the

seeds, he is silent about the existence of integuments, raphe, or chalaza, and none of his many analytical figures gives any information upon these subjects.

It is to be regretted that a very small amount of reliable information has been recorded concerning the carpical structure of the family. Among the few analyses that have been published, that of Gaertner is the most important: he shows in his work (i. 364, tab. 76. fig. 1) that of *Cordia* (*Sebestena*) *Myxa*, where the seed is suspended a little below the summit, with a raphe descending from that point to the base, its small radicle being superior, and its large fleshy cotyledons deeply plicated. A very different version of this structure, in a plant which he called *Cordia Myxa*, is given in Wight's 'Illustrations,' pl. 169: in the ovary the ovules are there shown to be quite erect, fixed in the basal angle of each cell; in the fruit the point of the attachment of the seed is not indicated, though it is drawn separately in fig. 11, without any mark of raphe or chalaza. This analysis is drawn by an Indian artist, and shows evident marks of inaccuracy; for the embryo, as shown in figs. 11 and 12, has a long pointed radicle, which is inferior (instead of superior). I therefore place more reliance upon the analysis of Gaertner, which is more conformable with my own observations, as will be shown presently. Wight's 'Icones,' also drawn by Indian artists, show the ovules in the same position as that indicated in the 'Illustrations,' in two other species of *Cordia*, in pls. 1379 and 1381, while in three other cases they are attached by their middle, as seen in plates 469, 1378, and 1380, which agrees with what I have generally found in the Brazilian species of *Cordia*. Prof. A. De Candolle, in a note to the genus *Varronia* (Prodr. ix. 468), states that the ovules are there laterally affixed to the internal angle of the cells; and, again, in another note (p. 471) he adds that he found the ovules in *C. gerascanthus* attached as in *Varronia*, and that in *C. Chamissoniana* (a closely allied species) the point of attachment is nearer the base; but my observations upon the same species convince me that the connexion is at the middle, rather above than below it: in *C. discolor* he found the ovules fixed as in *Varronia*. My examination of the unilocular nut of *Cordia glabra* shows that the seed, which tightly fits the cell, is attached by a somewhat broad hilum to a spot a little below the middle of the cell, from which point a line of raphe, imbedded between the two integuments *, descends

* The seed, as stated by Gaertner, has two integuments: the outer one, of very friable texture, quite white, is composed of numerous large cells rather laxly agglutinated together; but it adheres firmly to the inner integument, which is opaque, very finely reticulated, like an extremely

to a small basal chalaza; at the base of the nut, on the same side, a compressed open channel is seen, leading to the small abortive cells, filled with a chord of nourishing vessels which communicate with the hilum of the fertile seed. I have examined the ovaries and fruits of many Brazilian species of *Cordia*, all giving nearly similar results; and we may infer, from the preponderance of all this evidence, with a tolerable degree of confidence, that the ovules in the ovary or the seeds in their nuts are never affixed to the base of the cells, but are always attached nearer their middle, either above or below it, in the internal angle. In addition to this evidence, Roxburgh affirms of *C. serrata* that its ovules are affixed in the axis.

The *Cordia Myxa* of Roxburgh appears to me a very different plant from that figured by Wight, under that name, in his 'Illustrations,' in which the leaves are larger and the fruit is more than double the size. I have examined the fruit of *Cordia oblongifolia*, Thw., which corresponds completely in size, especially in the persistent calyx, with the figure of *C. Myxa* in Wight's 'Illustrations.' Here the drupe is almost globular, with a short conical apex, and is seated in a thick, striated, cupular calyx, with a denticulated margin; the pericarp is extraordinarily thick, composed of numerous coarse woody fibres, after the manner of a cocoa-nut, within which is a fleshy mesocarp that envelops the nut: this nut is scarcely more than half the length and one-third the breadth of the pericarp, and is marked externally with a few deep hollow punctures; it has two fertile cells (the other two being abortive), with a large hollow cavity in the base, which is continued up the axis in a narrow channel which is open at the toothed apex of the nut; here the seed in each cell is attached by its middle, certainly not below it, at the point where the placentary vessels from the central columella enter the cells in communication with the descending raphe. Roxburgh's *Cordia monoica* has a much smaller drupe, which is oblong, only ½ inch long, with a much thinner, fibrous pericarp, and a fleshy mesocarp covering a nut which has only a single seed, attached near its middle. *Cordia Bantamensis*, Bl., a species closely allied to the above, has an oblong apiculated drupe, longer and narrower than in *C. oblongifolia*, seated in its cupular calyx: the nut is 1-celled, with the indications of

thin waxy albumen; it is polished inside, and marked with several longitudinal nerve-like lines, produced by pressure between the plicatures of the cotyledons: but both these integuments are quite void of any vessels, except those of the raphe, which are enclosed in a sheath imbedded between them.

three abortive cells; the seed is here fixed above the middle of the cell, with a conspicuous descending raphe terminating in the basal chalaza. *Myxa* will make a good genus composed of several species, only a comparatively small portion of the 122 species classed in the section *Myxa* by De Candolle.

Cordia might conveniently be divided into several genera, for which good differential characters now exist. The form and æstivation of the calyx have already served for sectional divisions; but those of the corolla have been little attended to. Prof. De Candolle has noticed that the border of the corolla is campanulate and plicated convolutely in *Varronia*, as in the *Convolvulaceæ*; in *C. decandra*, Hook. & Arn., and *C. angiocarpa*, Rich., the stamens are twice or three times the usual number, and the lobes of the corolla, which are equally numerous, have a contorsively imbricated æstivation: in some species the border is corrugated, but in general the lobes of the border are quincuncially imbricated, in æstivation. It has not been noticed that in all the species forming the section *Gerascanthus* the border is cleft to the base into five equal flat lobes, which in æstivation are folded sinistrorsely, as in *Echites*: this generic name, established by P. Brown, might therefore be restored. The section *Rhabdocalyx* has one lobe of the border external in æstivation, while the other four are convoluted. The characters of the stamens and fruit afford other good indications. Besides the features I have mentioned as distinguishing *Myxa*, may be added that of its polygamous or monœcious flowers. *Cordia*, indeed, stands in much need of a thorough careful examination and redistribution.

There is one point deserving of notice—that, from some unknown cause, it rarely happens in *Cordia* that more than one ovule becomes fertilized; and this occurs equally in the plants of the Old and New World. The drupaceous nut is usually more or less gibbous and one-celled, with the seed attached as above described, in which case the abortive cells are generally seen on the flattened side, above the middle. May this almost constant abortion be owing to a defect in the stigmata, or to the puncture of insects, attracted perhaps by the nectariferous gland? I have seen cases where the flowers on a branch appeared quite perfect, but there was hardly one ovary in the whole that had not been attacked by a minute grub.

On a future occasion I will call attention to a new group of plants (the *Auxemmaceæ*), closely allied to *Cordiaceæ*, distinguished by the great augmentation of the calyx in fruit, by the peculiar æstivation of the corolla, and by its atropous ovules and seeds.